Name Key

## Unit 4 Practice Test: Solutions and Solution Stoichiometry

1. An unknown substance dissolves readily in water but not in benzene (a nonpolar solvent). Molecules of what type are present in the substance?

   a) neither polar nor nonpolar
   b) polar like dissolves like
   c) either polar or nonpolar
   d) nonpolar
   e) none of these

2. You have 2 solutions of chemical *A*. To determine which has the highest concentration of *A* in molarity, which of the following must you know? (circle all that apply)

   I. the mass in grams of *A* in each solution
   II. the molar mass of *A*
   III. the volume of water added to each solution
   IV. the total volume of the solution

3. A 20.0-g sample of HF is dissolved in water to give $2.0 \times 10^2$ mL of solution. The concentration of the solution is:

   a) 1.0 M
   b) 3.0 M
   c) 0.10 M
   d) 5.0 M
   e) 10.0 M

$$\frac{20.0\text{ g HF}}{.200\text{ L}} \left| \frac{1\text{ mol HF}}{20.008\text{ g HF}} \right. = 5.0\text{ M HF}$$

4 What mass of solute is contained in 256 mL of a 0.895 M ammonium chloride solution?

   a) 12.3 g
   b) 13.7 g
   c) 47.9 g
   d) 53.5 g
   e) none of these

$$.256\text{ L} \left| \frac{.895\text{ mol } NH_4Cl}{1\text{ L}} \right| \frac{53.492\text{ g}}{1\text{ mol } NH_4Cl} = 12.3\text{ g}$$

5. A strong electrolyte dissociates to a great extent in an aqueous solution.

6. You have 75.0 mL of a 2.50 M solution of $Na_2CrO_4$(aq). You also have 125 mL of a 2.50 M solution of $AgNO_3$(aq). What is the concentration of sodium ions after the two chemicals have reacted.

   ← 2 atoms per molecule

   a) 0 M
   b) 0.938 M
   c) 1.88 M
   d) 2.50 M
   e) 5.00 M

$$.0750\text{ L } Na_2CrO_4 \left| \frac{2.50\text{ mol}}{1\text{ L}} \right| \frac{2\text{ mol } Na^+}{1\text{ mol } Na_2CrO_4} = \frac{.375\text{ mol } Na^+}{.200\text{ L}} = 1.88\text{ M } Na^+$$

7. What volume of 18.0 M sulfuric acid must be used to prepare 15.5 L of 0.195 M $H_2SO_4$?

(a) 168 mL  b) 0.336 L  c) 92.3 mL
d) 226 mL  e) none of these

$M_1V_1 = M_2V_2$

$18.0 \cdot V_1 = .195M \cdot 15.5L$

$V_1 = .168L$

8. Write the balanced molecular equation for when sodium chloride and lead(II) nitrate react in an aqueous solution.

$2NaCl_{(aq)} + Pb(NO_3)_{2(aq)} \longrightarrow 2NaNO_{3(aq)} + PbCl_{2(s)}$

9. Write the net ionic equation for the reaction of aluminum sulfate and sodium hydroxide in aqueous solution.

molecular $Al_2(SO_4)_3 + 6NaOH \longrightarrow 2Al(OH)_{3(s)} + 3Na_2SO_4$

Total ionic $2Al^{3+} + \cancel{3SO_4^{2-}} + \cancel{6Na^+} + 6OH^- \longrightarrow 2Al(OH)_{3(s)} + \cancel{6Na^+} + \cancel{3SO_4^{2-}}$

net ionic $2Al^{3+} + 6OH^- \longrightarrow 2Al(OH)_{3(s)}$

cancel spectators

10. Which of the following is a strong acid? (Select all that apply)

a) HF  b) KOH  (c) $HClO_4$
(d) HCl  e) HBrO

11. Which of the following is *not* a strong base? (Select all that apply)

(a) $Ca(OH)_2$  b) KOH  (c) $NH_3$
d) LiOH  e) $Sr(OH)_2$

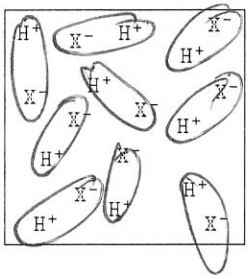
12. In writing the total ionic equation for the reaction (if any) that occurs when aqueous solutions of KOH and $Mg(NO_3)_2$ are mixed, which of the following would *not* be products?

~~a)~~ $NO_3^-$  ~~b)~~ $K^+$  ~~c)~~ $Mg(OH)_2$
(d) $KNO_3$ ← Is soluble  e) All of these would be produced

$2KOH + Mg(NO_3)_2 \longrightarrow Mg(OH)_{2(s)} + 2KNO_3$

$2K^+ + 2OH^- + Mg^{2+} + 2NO_3^- \longrightarrow Mg(OH)_{2(s)} + 2K^+ + 2NO_3^-$

13. A solid acid HX is mixed with water. After dissolving, the ions produced can be represented by the following model:



one $H^+$ per $X^-$ = monoprotic

ionized completely = strong acid

What type of acid is HX?

a) Strong monoprotic acid
b) Strong diprotic acid
c) Weak monoprotic acid
d) Weak diprotic acid
e) none of these

14. If all of the chloride in a 5.000-g sample of an unknown metal chloride is precipitated as AgCl with 70.90 mL of 0.2010 M $AgNO_3$, what is the percentage of chloride in the sample?

a) 50.55%
b) 10.10%
c) 1.425%
d) 20.22%
e) none of the above

$MCl_x + AgNO_3 \rightarrow AgCl + M(NO_3)_x$

$$\frac{.07090\ L}{1\ L} \left| \frac{.2010\ mol\ AgNO_3}{1\ mol\ AgNO_3} \right| \frac{1\ mol\ Ag^+}{1\ mol\ Ag^+} \left| \frac{1\ mol\ Cl^-}{1\ mol\ Cl^-} \right| \frac{35.45\ g\ Cl^-}{1\ mol\ Cl^-} = .505\ g\ Cl^-$$

$$\frac{.505\ g\ Cl^-}{5.000\ g\ MCl_x} \times 100 = 10.1\%\ Cl^-$$

15. Sulfamic acid, $HSO_3NH_2$ (molar mass = 97.1 g/mol), is a strong monoprotic acid that can be used to standardize a strong base:

$$HSO_3NH_2(aq) + KOH(aq) \rightarrow KSO_2NH_2(aq) + H_2O(l)$$

A 0.179-g sample of $HSO_3NH_2$ required 19.4 mL of an aqueous solution of KOH for a complete reaction. What is the molarity of the KOH solution?

a) 9.25 M
b) $9.50 \times 10^{-5}$ M
c) 0.0950 M
d) 0.194 M
e) none of these

$$\frac{.179\ g\ HSO_3NH_2}{97.104\ g\ HSO_3NH_2} \left| \frac{1\ mol\ HSO_3NH_2}{} \right. = .00184\ mol\ Acid$$

$.00184\ mol = M_b V_b$

$.00184\ mol = M_b (.0194\ L)$

$M_b = .0950\ M$

This is exactly what we did in our lab day 1.

16. The following reactions

$ZnBr_2(aq) + 2AgNO_3(aq) \rightarrow Zn(NO_3)_2(aq) + 2AgBr(s)$

$KBr(aq) + AgNO_3(aq) \rightarrow AgBr(s) + KNO_3(aq)$

are both examples of

a) oxidation-reduction reactions.
b) acid-base reactions.
c) precipitation reactions.
d) a and c
e) none of these

17. Classify each of the following reactions as either Precipitation, Acid-Base or Redox equations.

a. $Pb^{2+} + 2I^- \rightarrow PbI_2$ ← not soluble — precipitation

b. $2Ce^{4+} + 2I^- \rightarrow I_2 + 2Ce^{3+}$ — Redox

c. $HOAc + NH_3 \rightarrow NH_4^+ + OAc^-$ — Acid - Base

18. In the reaction $\overset{0}{P_4}(s) + 10\overset{0}{Cl_2}(g) \rightarrow 4\overset{+5}{\downarrow}\overset{-1}{\swarrow}PCl_5(s)$, the reducing agent is

a) chlorine. (oops)
b) $PCl_5$.
c) phosphorus.
d) $Cl^-$.
e) none of these

19. Which of the following statements is *not* true?

a) When a metal reacts with a nonmetal, an ionic compound is formed.
b) A metal-nonmetal reaction can always be assumed to be an oxidation-reduction reaction.
c) Two nonmetals can undergo an oxidation-reduction reaction.
d) When two nonmetals react, the compound formed is ~~ionic~~ covalent
e) A metal-nonmetal reaction involves electron transfer.

ionic requires a metal or $NH_4^+$

20. In the reaction $\overset{0}{Zn} + H_2SO_4 \rightarrow \overset{+2}{ZnSO_4} + H_2$, which, if any, element is oxidized?

a) zinc — loses $2e^-$
b) hydrogen
c) sulfur
d) oxygen
e) none of these

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21. Which of the following reactions does *not* involve oxidation-reduction?

a) $CH_4 + 3O_2 \rightarrow 2H_2O + CO_2$
b) $Zn + 2HCl \rightarrow ZnCl_2 + H_2$
c) $2Na + 2H_2O \rightarrow 2NaOH + H_2$
d) $MnO_2 + 4HCl \rightarrow Cl_2 + 2H_2O + MnCl_2$
e) All are oxidation-reduction reactions.

Anytime a pure element forms a compound (or visa versa) it is redox.

22. The oxidation state of iodine in $IO_3^-$ is:

a) 0 b) +3 c) −3 d) +5 e) −5

23. Balance the following oxidation-reduction reaction using the half-reaction method:

$Fe^{3+} + I^- \rightarrow Fe^{2+} + I_2$

$(e^- + Fe^{3+} \rightarrow Fe^{2+}) \times 2$

$2I^- \rightarrow I_2 + 2e^-$

$2Fe^{3+} + 2I^- \rightarrow 2Fe^{2+} + I_2$

24. Balance the following redox equation in acid solution:

$NO_3^- + I^- \rightarrow IO_3^- + NO_2$

$(e^- + 2H^+ + NO_3^- \rightarrow NO_2 + H_2O) \times 6$

$3H_2O + I^- \rightarrow IO_3^- + 6H^+ + 6e^-$

$6H^+ + 6NO_3^- + I^- \rightarrow 6NO_2 + IO_3^- + 3H_2O$

25. Balance the following reaction in basic solution:

$MnO_4^{2-} + CN^- \rightarrow MnO_2 + CNO^-$

$(3e^- + 4H^+ + MnO_4^{2-} \rightarrow MnO_2 + 2H_2O) \times 2$

$(H_2O + CN^- \rightarrow CNO^- + 2H^+ + 2e^-) \times 3$

$2H^+ + 2MnO_4^- + 3CN^- \rightarrow 2MnO_2 + 3CNO^- + H_2O$

$+2OH^-$ $+2OH^-$

~~$2H_2O$~~ $+ 2MnO_4^- + 3CN^- \rightarrow 2MnO_2 + 3CNO^- +$ ~~$H_2O$~~ $+ 2OH^-$